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**Wisconsin  
Consortium on  
BioBased Industry**



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## ACKNOWLEDGEMENTS

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## EXECUTIVE SUMMARY

**W**isconsin's agricultural and forest resources in concert with its manufacturing base, educational institutions and well-trained workforce put it in a prime position to make the transition to a bioeconomy. Wisconsin needs to act quickly and decisively to define its unique role in this emerging economic opportunity.

### The Bioeconomy

The petroleum-based economy has been dominant only for the past century. The convergence of global economic, political and technical forces provides the impetus for a new look at the economic opportunities in renewable resources and biobased alternatives to petroleum.

Rising oil prices, supply uncertainty and biotechnology advances have focused increased interest on the "bioeconomy" as a way to replace costly non-renewable petroleum with renewable resources. Many experts are convinced that we have reached a tipping point and the world's fuels, energy, chemicals and other materials will begin a rapid transition from the petroleum economy to a bioeconomy. The foundation of the bioeconomy is the renewable plant and organic materials mainly produced by farms and forests which are

already major pillars of Wisconsin's economy. The dairy, food processing, forest products and paper industries in Wisconsin are well positioned to play leading roles in this historic shift in the state's economy.

### Moving Wisconsin into the Bioeconomy

Governor Doyle appointed a 20-member Consortium on Biobased Industry in May 2005 to identify opportunities for Wisconsin businesses to expand their role in the emerging bioeconomy.

In appointing the Consortium, Governor Doyle challenged it to "...consult with industry experts, stakeholders and the public at large" and:

- Recommend state goals for the development and use of biobased products and bioenergy in an environmentally sound manner;

- Recommend short- and long-term policies and commercialization strategies that will help achieve those goals;
- Propose ways that Wisconsin can incorporate federal and state programs, integrated planning and regional cooperation to reach the goals;
- Identify mechanisms that encourage and support private sector initiatives in biobased product development;
- Advise on policies at the local, state and federal level that would support development of biobased products and energy as well as new and expanding markets to support them.<sup>1</sup>



Photo by Warren Gretz  
Courtesy DOE/NREL

Wisconsin businesses and individuals spend over \$15 billion each year for their energy needs. About two-thirds of that amount leaves the state, with no further economic benefit to Wisconsin.

The Consortium reports that Wisconsin not only should, but must, pursue the bioeconomy as vigorously as possible. This effort must not be a one-time activity, but rather an ongoing public and private effort to actively address the dynamic nature of building and strengthening new and existing industries in Wisconsin. This report identifies actions that the State of Wisconsin must take to create the environment in which Wisconsin businesses can maximize the potential of our state's resources and succeed in the bioeconomy.

The Consortium identifies the following advantages of a bioeconomy for Wisconsin:

#### CREATING GOOD JOBS AND BUSINESS OPPORTUNITIES

Many activities of the bioeconomy tend to occur in rural areas, near the source of raw materials. However, these activities also create major new opportunities for urban businesses to manufacture biobased products and equipment, provide construction and maintenance services or any of a long list of other support services needed by bioeconomy firms. The Renewable Energy Policy Project, in a study of the impact of a major commitment to renewable energy, estimated that Wisconsin would rank fourth in terms of job creation and fifth in terms of total investment among all states.<sup>2</sup>

#### REDUCING DEPENDENCE ON IMPORTED ENERGY

Wisconsin businesses and individuals spend over \$15 billion each year for their energy needs. About two-thirds of that amount leaves the state, with no further economic benefit to Wisconsin. Money spent for energy produced from Wisconsin resources stays in the state and boosts the economy.

#### REDUCING ENVIRONMENTAL AND GREENHOUSE GAS IMPACTS

Using biomass to produce electric power or liquid transportation fuel replaces nonrenewable fossil fuels with a renewable, nearly carbon-neutral fuel. The Environmental Protection Agency (EPA) reports that more than half of U.S. energy related greenhouse gas (GHG) emissions come from stationary sources such as electric generation. Another one-third comes from mobile sources, such as automobiles.



Courtesy: Energy Center of Wisconsin

### The Work of the Consortium on Biobased Industry

The members of the Consortium approached their task with these basic values:

- Biobased economic development must be industry-driven. Success will be built on the strong support and participation of entrepreneurs and businesses working in unison with the public sector.
- Success will not happen overnight. While there are near-term achievable results, building a major new economic sector requires a long-term commitment.

<sup>1</sup> Governor Jim Doyle, Executive Order #101, dated May 27, 2005.

<sup>2</sup> Sterzinger, George, et.al., Renewable Energy Policy Project, "Component Manufacturing: Wisconsin's Future in the Renewable Energy Industry", January 2006.

- Biobased development in Wisconsin should, as much as possible, maximize ownership opportunities for Wisconsin farmers, forest landowners, forest industries, workers and residents.
- Success will require global awareness, local excellence and continuous innovation to compete for the highest value opportunities.

The findings and recommendations of the Consortium are based on a technical study, "Biobased Industry Opportunities and Advantages," conducted in 2005 by a team led by the Energy Center of Wisconsin. For the study, the team analyzed the organic raw materials, conversion technologies and final products available in Wisconsin. Based on that analysis, the team identified eight areas that it concluded would encompass the bulk of the biobased industry opportunities in Wisconsin. These opportunity areas offer a focus for harnessing Wisconsin's critical assets to build its biobased economy.

### CORE STRATEGIES

The Consortium developed a three-pronged strategy to guide its decisions for developing the bioeconomy in Wisconsin:

#### 1. Strengthen Wisconsin's core industries through biobased technologies

Retaining, strengthening and growing existing core industries through bioindustry technology adoption should be a priority strategy. Wisconsin's historically high value adding agriculture, food and forest products industries can reduce costs and strengthen competitiveness through integration of biorefining<sup>3</sup> technologies.

#### 2. Enhance emerging biobased industries

Wisconsin biobased businesses and emerging industries that incorporate new biobased technologies need continuing support so they can build their market share. Wisconsin's rapidly growing ethanol industry and the market for anaerobic digesters are two such examples.

These emerging industries and technologies need a supportive climate of economic development programs, efficient and effective regulatory oversight, and market friendly programs that encourage market building through a variety of mechanisms.

### 3. Establish leadership in "leapfrog" technologies

Discoveries that leapfrog intermediate processes or existing infrastructure offer the opportunity to develop and commercialize significant new technologies. Developing these technologies requires a strong and fertile research environment coupled with a supportive business climate for transferring those discoveries into commercial products. The research and development capabilities of the University of Wisconsin System are essential resources for establishing and supporting a market leadership position and helping Wisconsin establish itself as a leader in the bioeconomy.

## Recommendations

The Consortium's recommendations to the Governor fall into four categories<sup>4</sup> that each contains specific actions to be incorporated into an implementation plan.

#### CREATE THE WISCONSIN BIOINDUSTRY PARTNERSHIP (WBIP)

Wisconsin needs an organizing structure to sustain a long-term commitment to and progress in building Wisconsin's bioindustry. The WBIP will provide a broad base of support for multi-agency and organization coordination, research and development, outreach, business and workforce development, and funding. The WBIP will be charged with detailing the implementation mechanisms of the Consortium's recommendations, once accepted by the Governor. The Consortium envisions the WBIP as the coordinating and integrating body for Wisconsin's bioindustry development programs.



Photo by Warren Gretz  
Courtesy DOE/NREL

Wisconsin biobased businesses and emerging industries that incorporate new biobased technologies need continuing support so they can build their market share.

<sup>3</sup> Biorefining is the term used to identify a combination of technologies that can convert a biobased feedstock into multiple products. It is similar to the concept of a petroleum refinery.

<sup>4</sup> See "Policy Recommendations" for numerous detailed policy options presented by the Energy Center and reviewed by the Consortium. Available at: [www.bioeconomy.wi.gov](http://www.bioeconomy.wi.gov).



Photo by Dave Parsons  
Courtesy DOE/NREL

Entrepreneurs as well as existing businesses embarking on new ventures need a broad range of support and encouragement.

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#### **BUILD RESEARCH AND DEVELOPMENT CAPACITY**

The University of Wisconsin's research capabilities coupled with the education and training resources of the University System and the Wisconsin Technical College System are essential to establishing Wisconsin as a biobased industry leader. Targeted, industry-driven research and mechanisms for transferring that research to the market are fundamental to building this industry. There are significant opportunities to leverage state and private funds with federal research grants.

#### **DEVELOP SPECIALIZED BUSINESS SUPPORT PROGRAMS**

Entrepreneurs as well as existing businesses embarking on new ventures need a broad range of support and encouragement. This support includes access to business and techni-

cal training programs, flexible forms of financing, an engaged regulatory system that understands biobased technologies, targeted tax incentives and aggressive help in finding potential partners. The WBIP should assure that the full range of these services is readily available to bioeconomy entrepreneurs.

#### **BUILD MARKETS AND DEMAND**

The State of Wisconsin can build demand for biobased products through its considerable purchasing power. The WBIP should develop a detailed implementation plan that considers a state procurement policy that favors biobased products. It should also identify other purchasing incentives as well as new and improved ways to help spur consumer acceptance of the biobased products made in Wisconsin.

# WISCONSIN AND THE BIOECONOMY



**T**he bioeconomy is a dynamic and unique economic development opportunity for Wisconsin as the state strategically repositions its manufacturing base for global change and competition. The bioeconomy, as a vehicle for reducing climate change emissions and other undesirable impacts from a petroleum-based economy, is right for the environment.

Wisconsin can enhance its agriculture, forestry, manufacturing and life sciences sectors by seizing the value-added opportunities available in the emerging transition to biobased industries. Wisconsin can direct new business opportunities to renewable crops, organic wastes, and new raw materials as a source of fuels, energy and products to economically and environmentally sustain our state.

The first wave of this biobased industry transformation is already underway in Wisconsin, the United States and throughout the world. Ethanol increasingly penetrates the transportation fuel market and biodiesel is emerging as an alternative to petroleum-based diesel fuel. This growing market share for biofuels is driven by rising fossil fuel costs, rapidly advancing technologies, geo-political factors and environmental issues.

Renewable plants and organic materials (biomass) provide the natural resource base for creating biobased industry. A biorefinery facility integrates biomass conversion processes and equipment to produce fuels, power, and chemicals from biomass. It is analogous to a refinery that produces multiple fuels and products from petroleum. Similarly, biorefining will position biopower and bioproducts for new market opportunities.

The Midwest, including Wisconsin, has rich agricultural and forest lands—abundant natural resources for producing biomass. Coupling these resources to biorefineries provides opportunities to strengthen Wisconsin's existing businesses and build new value-adding businesses. It offers Wisconsin and the Midwest the opportunity to be a national and even global leader in the bioeconomy.



Achieving this bold goal requires creativity, flexibility and sustained effort by the private and public sectors to capture the opportunities. In May, 2005 Governor Jim Doyle appointed a 20-member Consortium on Biobased Industry to recommend the steps that Wisconsin must take to maximize its advantages in this rapidly developing field. The Consortium was asked to identify opportunities for Wisconsin to expand its role in the emerging biobased industries of energy, fuels, chemicals and materials, and to recommend strategies that create sustained competitive advantages for Wisconsin businesses and workers. Governor Doyle challenges government, education, business and residents to harness Wisconsin's critical resources in ways that add value to farms and forests—the working lands of Wisconsin—and that offer opportunities for manufacturers and entrepreneurs to create jobs that have positive impacts for Wisconsin.



Photo by NYSERDA  
Courtesy DOE/NREL

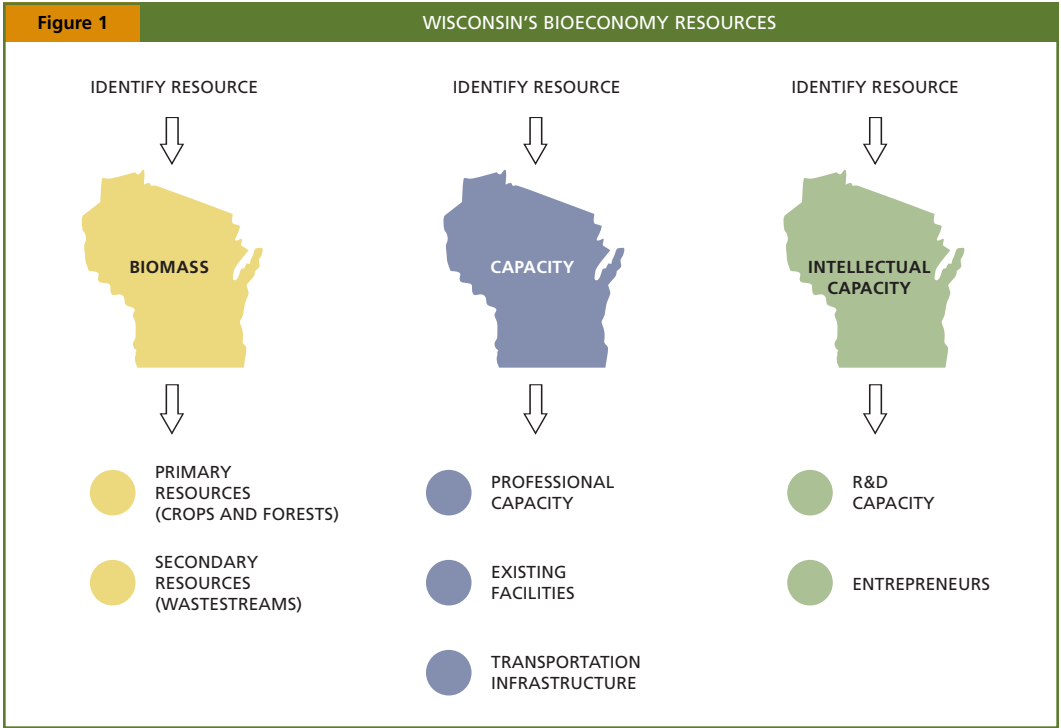
Wisconsin's farmers, foresters, manufacturers and business community know how to create value and have done so for years.

an economy founded on renewable biobased products and industries. This initiative is not a one time opportunity, but rather the start of an ongoing public and private effort to actively address the dynamic nature of building and strengthening new and existing industries.

### Wisconsin's Drive to Bioeconomy Leadership

Wisconsin's farmers, foresters, manufacturers and business community know how to create value and have done so for years. They have created value using the same biomass feedstocks that will be the foundation of the bioeconomy—agriculture crops and crop residues, timber and pulp wood, forest residues, food processing wastes, livestock production wastes, and municipal solid waste.

The Consortium has identified several driving forces and supportive conditions that increase bioeconomy opportunities for Wisconsin. These include:





- An accelerating market shift from fossil fuels toward locally-grown biomass as the raw material for energy, fuel, and chemical production.
- Financial, functional and environmental performance requirements across a wide variety of biobased products that now compete favorably with petroleum based products.
- An increasingly supportive federal policy toward renewable energy, biofuels and biobased products.
- Innovative institutions and policies within the Midwest that support biobased development.
- Midwest's regional advantage in its capacity to produce biomass sufficient to support both a commodity and a high value biobased economy.
- Increased business start up activity and major corporate shifts to biobased development and commercialization strategies that result in new technologies and new products.
- World-class research facilities and a premier educational system that offers the required intellectual and human capital necessary for the bioeconomy.

Combined, these forces and conditions create the framework in which to build a thriving economic engine, not only in Wisconsin, but across the Midwest. The Midwest can become the nation's "biobelt" for renewable energy, biorefining and biobased products. The Consortium has recommended strategies that will position Wisconsin to lead the Midwest in key areas of bioeconomic development.

## Preparing Wisconsin for the Bioeconomy

Governor Doyle has launched several initiatives to ensure Wisconsin has a strong and viable economy. These initiatives help pave the way for Wisconsin's transition to a bioeconomy.

The manufacturing, agriculture and forestry sectors are under intense global competitive pressure, resulting in lost jobs and reduced wages. In September 2003 Governor Doyle

announced the **Grow Wisconsin Initiative**, with eight strategic goals:

- Retain and Create High Wage Jobs
- Prepare Workers for Tomorrow's Economy
- Add Value in Wisconsin's Economic Base
- Create and Unleash Knowledge to Build Emerging Industries
- Tap Wisconsin's Full Urban Potential
- Implement Strategies Regionally
- Lower Regulatory Burdens, Keep Standards High
- Build a World Class Infrastructure

Further, Governor Doyle understands that energy issues are integral to his priority of growing the state's economy. He created the **Task Force on Energy Efficiency and Renewables** to "advise the Governor on creative, consensus policy options and practical business initiatives to restore Wisconsin as a leader in energy efficiency and renewable energy sources, relying upon cooperation among the stakeholders in the energy industry with the goal of reducing Wisconsin's dependence on out-of-state energy and helping to save taxpayers money." The Governor signed legislation recommended by the Task Force into law on March 17, 2006 (2005 Wisconsin Act 141) which:

- Requires that 10% of the electric power sold in Wisconsin come from renewable sources by 2015;
- Establishes a goal of 10% of electricity used by state agencies coming from renewable sources by 2007;
- Establishes a goal of 20% of electricity used by state agencies coming from renewable sources by 2011.

Department of Agriculture, Trade and Consumer Protection Secretary Rod Nilsestuen created the **Working Lands Initiative** to assure that land resources critical to Wisconsin's future be protected and preserved. The potential to obtain significant energy and bioproduct resources from agricultural and forest resources is a critical factor in designing new

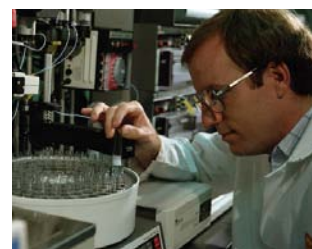


Photo by Warren Gretz  
Courtesy DOE/NREL

The Midwest can become the nation's "biobelt" for renewable energy, biorefining and biobased products.



Photo: University of Minnesota  
Courtesy DOE/NREL

The potential to obtain significant energy and bioproduct resources from agricultural and forest resources is a critical factor in designing new state policies that preserve our working lands.

state policies that preserve our working lands. To make sure an adequate land base exists in the future for Wisconsin agriculture and forestry biomass, the Consortium agrees that the Working Lands Initiative steering committee final recommendations be considered as a part of the long-term implementation strategy for the Wisconsin bioeconomy.

#### COMPETITION FROM OTHER STATES

Wisconsin is not the only state, especially in the Midwest, to have realized the value of the bioeconomy to its future. The competition will be fierce and includes a full range of support, from property, excise and sales tax exemptions to common loan and rebate programs that encourage bioindustry development. Many of the largest funding sources are broadly based, but clearly include bioeconomy support. Iowa has leveraged \$100 million in federal money with over \$400 million of state funds to create the Grow Iowa Value Fund, which supports economic development, including alternative

fuels and the bioeconomy. Michigan has invested \$1 million in the Michigan Biotechnology Institute and also made \$400 million available for alternative energy, life science and advanced manufacturing development purposes. Ohio has invested \$11.6 million in the Ohio Bioproduct Innovation Center. Minnesota launched the Initiative for Renewable Energy and Environment coordinating academic research for the bioeconomy. Minnesota also has creative tax incentives for biofuels. In Canada, the Ontario government has been more targeted. It has initiated the Ontario Ethanol Growth Fund, a 12-year, \$520 million program. Another \$20 million and \$30 million (Canadian) have been provided for the Biotech Commercialization Center and a Biotech Cluster Innovation Program, respectively.

New York, California, New Mexico and other states have also made significant financial commitments to the bioeconomy.



## GOVERNOR'S CONSORTIUM ON BIOBASED INDUSTRY

**G**overnor Doyle signed Executive Order #101 creating the Consortium on Biobased Industry on May 27, 2005 and asked the 20 stakeholder members to recommend short- and long-term policy and commercialization strategies to promote the development and use of biobased products and bioenergy in an environmentally sound manner. The Governor acknowledged the “vast complexity of the biobased industry,” and directed the Consortium to “review the science, economics and socio-political implications of its pursuit and propose tactical and strategic steps that Wisconsin can take to assume a leadership role in this field.”

The members of the Consortium approached their task with these basic values:

- Biobased economic development must be industry-driven. Success will be built on the strong support and participation of entrepreneurs and businesses working in unison with the public sector.
- Success will not happen overnight. While there are near-term achievable results, building a major new economic sector requires a long-term commitment.
- Biobased development in Wisconsin should, as much as possible, maximize ownership opportunities for Wisconsin farmers, forest landowners, forest industries, workers and residents.
- Success will require global awareness, local excellence and continuous innovation to compete for the highest value opportunities.

The Consortium heard from bioeconomy experts and used the Biobased Industry Opportunities and Advantages study to guide its recommendations. The Consortium, when meeting for the first time in June 2005, adopted the following vision for Wisconsin's bioeconomy:

*Wisconsin will be a national leader in the use of biologically based materials to produce energy and products that effectively compete with petrochemicals in quality, cost and environmental impact.*

### Scope of the Bioeconomy

The Consortium clarified the scope of its mission to match and help leverage the efforts of the federal government. The bioeconomy refers to a fundamental shift from petroleum to renewable biomass-based raw materials for



Photo by Dave Parsons  
Courtesy DOE/NREL

The transition to a bioeconomy offers Wisconsin many broad economic and environmental benefits while also strengthening its businesses and industries.

use in several large components of the U.S. economy. The U.S. Department of Energy divides it into the following discrete sectors:

**BioFuels** are liquid fuels produced from biomass. Currently, ethanol is the major biofuel; biodiesel is in early stage growth and eventually even more advanced fuels can come from today's hydrogen research.

**BioPower** refers to the generation of electricity from biomass resources and can be as simple as burning waste products or can involve advanced gasification technology that increases efficiency and improves environmental performance.

**BioProducts** represents a range of products, many in development, that promise to replace today's familiar petrochemical based products. They include fine and specialty chemicals, plastics feedstocks, fabric, pharmaceuticals, and neutraceuticals.

## Setting Goals and Making Progress

The federal Biomass Research and Development Act of 2000 produced the "Vision for Bioenergy and Biobased Products in the United States"<sup>5</sup> and established the following national goals that, if met, will reduce our national petroleum consumption by 30% over the next 15 years.

Share of Bioenergy Products Replacing Petroleum			
	2010	2020	2030
BioFuels	4%	10%	20%
BioPower	4%	5%	5%
BioProducts	12%	18%	25%

The Consortium believes that Wisconsin must work to help the country meet these goals and that Wisconsin can, in fact, lead in this effort.

Wisconsin currently ranks number seven among states in ethanol production; state firms have a

market share of about five percent. Wisconsin should strive to increase its share of the national ethanol market as it grows in line with national goals.

Wisconsin Act 141, which establishes the goal of obtaining 10% of the state's electric power from renewable sources, provides an immediate opportunity to support the bioeconomy. The Consortium recommends that one-half of that renewable power should be bioenergy based on the use of Wisconsin biomass resources.

Some experts have forecasted dramatic growth in the use of biomass resources by the chemical industry over the next decade. The Consortium believes that Wisconsin can take its place as one of the top ten states in the use of biomass to produce bioproducts.

Meeting these goals will ensure that Wisconsin is a leader in the bioeconomy at the same time that Wisconsin residents enjoy the economic, environmental and energy security benefits of that effort. The resource base provided by the crop and forest lands of Wisconsin has been a critical component of the state's economy throughout its history and will remain so in the future if we are to build a successful bioeconomy.

## Benefits of the Bioeconomy

The transition to a bioeconomy offers Wisconsin many broad economic and environmental benefits while also strengthening its businesses and industries.

### CREATE GOOD JOBS

Manufacturing facilities that support the bioeconomy tend to locate in rural areas, near the source of their raw materials. However, only about 15% of the jobs that can be attributed to a bioindustry facility are created directly at the plant. Many are created when the plant buys supplies and raw materials. For example, we have seen increases in stainless steel fabri-

5 U.S. Department of Energy, Vision for Bioenergy and Biobased Products in the United States, October 2002.

cation attributable to ethanol plant construction. Economic impact studies conducted by the Center on Wisconsin Strategies indicate that, for every \$1 spent to purchase Wisconsin produced ethanol, the state as a whole realizes \$1.75 in additional economic activity. They also estimate that every 55,000 gallons of ethanol produced creates one additional job. Wisconsin currently has production capacity in use or under construction for over 200 million gallons of ethanol, suggesting over 3,500 jobs associated with the industry, only about 15% of them directly employed at ethanol plants.



#### REDUCE DEPENDENCE ON IMPORTED ENERGY

Wisconsin businesses and individuals spend over \$15 billion each year to pay for their energy needs. About two-thirds of that amount leaves the state, with no further economic benefit to Wisconsin. The Consortium believes that if Wisconsin makes an aggressive and sustained long-term commitment to producing biofuels we will significantly reduce our reliance, and that of the country, on petroleum imported from unstable countries. This shift will provide the economic benefits described above, as well.

#### REDUCE ENVIRONMENTAL AND GREENHOUSE GAS IMPACTS

Using biomass to produce electric power or liquid transportation fuel replaces nonrenewable fossil fuels with a renewable, nearly carbon-

neutral fuel. It also creates the opportunity for carbon sequestration and for capturing economic benefits associated with carbon trading. The EPA reports in the U.S. Greenhouse Gas Inventory that more than half of U.S. energy related GHG emissions come from stationary sources such as electric generation. Another one-third comes from mobile sources such as automobiles.

Biofuels are nearly carbon neutral fuels. The carbon dioxide released when biofuels are consumed is captured by plants and trees and recycled, with no net increase in atmospheric carbon dioxide. However, carbon may be released to the extent that fossil fuels are used in the farming and manufacturing processes. Argonne National Laboratory has determined that the use of corn-based E85 ethanol reduces greenhouse gases by 19 to 26% compared to gasoline. This jumps to at least 85% or better when cellulosic ethanol is considered.

Other environmental benefits with biobased technologies and products include:

- Reducing ground and surface water contamination resulting from spilled MTBE (methyl tertiary-butyl ether). Ethanol, a naturally occurring product of the fermentation of organic matter, biodegrades more quickly when spilled than MTBE. Many states have banned the gasoline oxygenate MTBE because of its link to ground and surface water contamination problems.
- Reducing pollution and odor problems associated with manure management on dairy farms. Anaerobic digesters convert manure into electricity or biogas with significant value to the farmer and turn a disposal and odor problem into a valuable product.
- Reducing air and water pollution through the use of green technologies and processes that have a more benign impact on the environment relative to petroleum-based products.

The Consortium realizes that no technology, including biobased technologies, is without



Photo by Bonnie Hames  
Courtesy DOE/NREL

Wisconsin businesses and individuals spend over \$15 billion each year to pay for their energy needs. About two-thirds of that amount leaves the state, with no further economic benefit to Wisconsin.



Photo by Art Wiselogel  
Courtesy DOE/NREL

Wisconsin businesses will benefit in several direct ways from the bioeconomy.

environmental consequences or trade offs. Wisconsin must continue to exercise diligence in identifying and avoiding environmental risk from any new technology.

#### STRENGTHEN WISCONSIN BUSINESSES

Wisconsin businesses will benefit in several direct ways from the bioeconomy. Integrating biorefining and biobased products into the state's production and manufacturing processes will:

- Increase Wisconsin's major manufacturers' competitiveness. Incorporating biorefining technologies will reduce energy and waste disposal costs and add new revenue streams. The Consortium expects these benefits to be a significant factor in the continued ability of some firms to remain competitive globally.
- Provide additional value from land resources. Biorefining and tradable environmental and energy credits such as carbon sequestration

credits can be used as tools to obtain additional value from land resources. These benefits will be geographically dispersed due to the economics and logistics of biorefineries. It will require the availability of working lands to make biomass production possible.

- Enhance the opportunities for entrepreneurs. The transition to a bioeconomy will engender numerous opportunities for developing new business as providers of raw material, intellectual property, technology and enzyme and catalysis inputs, equipment suppliers, marketers, and consultants.
- Attract funding for research and education. As Wisconsin's commitment to the bioeconomy increases, the University System will attract new research funding and technical colleges will be able to fund additional education and training programs. This funding will support basic and applied research and workforce development as key ingredients of biobased industry development.



# THE OPPORTUNITIES AND ADVANTAGES STUDY



In 2005, the Wisconsin Departments of Administration, Natural Resources and Agriculture, Trade and Consumer Protection commissioned a study on “Biobased Industry Opportunities and Advantages.” The purpose of the study was to help the Consortium establish strategies and recommendations for moving Wisconsin into the bioeconomy.<sup>6</sup>

The study identifies a set of resource product channels that best fit Wisconsin’s feed stocks, existing farm, forestry and manufacturing industries and the technologies where performance and costs are most favorable for near- and long-term development. It notes that Wisconsin’s advantage lies in its sizeable and diverse agriculture, forestry and manufacturing sectors, plus its anchor to the biological and biochemical research capabilities of the University of Wisconsin.

The concept of Resource-Product-Chains (RPC) was used to catalog Wisconsin’s physical resources. The RPC consists of potential feed-stock, processing technology and end product combinations. The study identified 650 such combinations and analyzed them for near- and intermediate-term promise.

Analyses show that eight key technologies capture the bulk of the biobased opportunities in Wisconsin. These are:

- Anaerobic digestion
- Biomass gasification
- Combustion
- Fermentation of 6-carbon sugars
- Fermentation of lignocellulosic biomass
- Fiber composites manufacturing
- Pyrolysis
- Transesterification

In addition to identifying the technologies that could capture biobased opportunities, the study also identified the drivers that would lead business to pursue biobased development. Some opportunities were perceived as more supply enabled and others more demand enabled given technologies available or likely in the future. Figure 2 on page 16 illustrates the key supply- and demand-side drivers identified in the study.

<sup>6</sup> The Energy Center of Wisconsin was the lead contractor for a team that included the Center on Wisconsin Strategies, the Center for Technology Transfer, GDS Associates, and Resource Strategies Inc. The team produced three reports: 1) Whitepaper on the Policy and Economic Rationale for Shifting to a Biobased Economy; 2) Technical Analyses of Biobased Opportunities and Potential for Wisconsin Advantage; and 3) Policy Recommendations. The complete analyses can be found at [www.bioeconomy.wi.gov](http://www.bioeconomy.wi.gov).



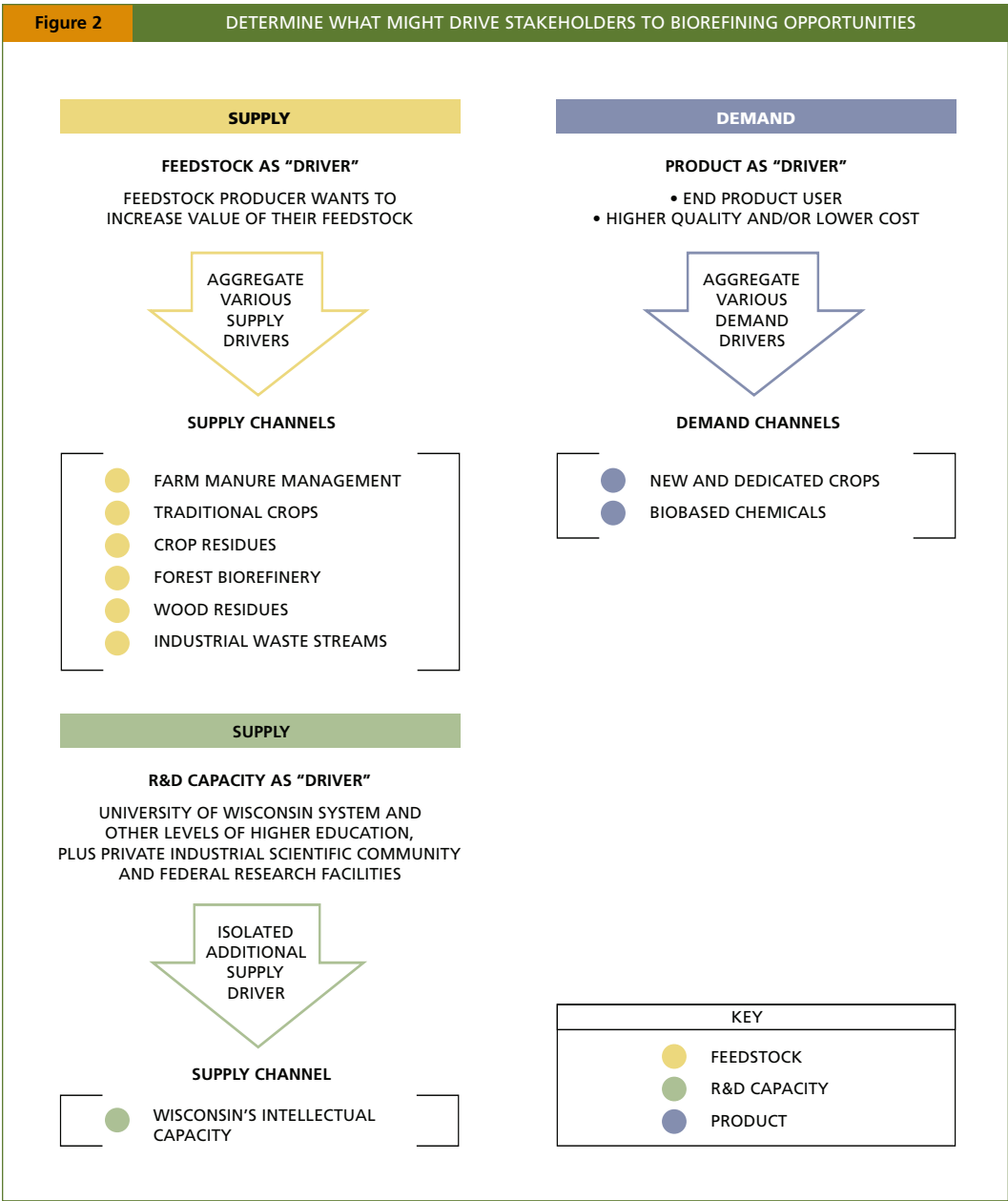
(right) The Opportunities and Advantages Study describes the “drivers” stimulating the development of Wisconsin’s bioeconomy.

Source: Energy Center of Wisconsin



Photo by Warren Gretz  
Courtesy DOE/NREL

Many areas of Wisconsin’s economy have the potential to expand biobased activity.



The study also noted that there are significant risks to adapting biobased technologies. Risks include underdeveloped infrastructure for material handling, unproven or emerging technologies, and underdeveloped markets for many of the biobased products. Biobased industries need strong support from both “push” and “pull” strategies. Push strategies involve mar-

shalling R&D resources to focus on biobased industry. That research then needs to be backed by a strong commercialization policy. Pull strategies involve building biobased product markets through government purchasing or incentives that encourage private sector use. Wisconsin will need to employ a combination of push and pull strategies to move into the bioeconomy.

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Many areas of Wisconsin's economy have the potential to expand biobased activity. However, the state lacks a cohesive focus and vision that would allow it to realize the near-term and longer-term potential of biobased industry and product opportunities. Moreover, improved regional coordination would help Wisconsin, as well as neighboring states make the most of development opportunities.

A passive approach to biobased industry development will not work. It will take a serious effort to coordinate the many skills and functions required to succeed in the bioeconomy. Biobased industry development will complement, and in many ways, be modeled after the significant progress made in Wisconsin with life science biotechnology. There is a great body of common knowledge and skills that can and should be transferred. The important difference is that the benefits of industrial biotechnology are likely to be more widely distributed across the state, and opportunities for producer ownership are more reachable.

## Wisconsin's Bioindustry Development Opportunities

Following are brief descriptions of Wisconsin's major bioindustry development opportunities.

### MANURE TECHNOLOGIES

**Anaerobic digestion** using livestock manure as a feedstock produces biopower and bioproducts. Anaerobic digestion offers the best understood and most cost effective solution for manure management in the near term. Anaerobic digestion uses bacterial decomposition of the organic matter in an oxygen-free and temperature controlled environment to produce usable quantities of biogas. The biogas can then be used to fuel an electric generator or for other space heating needs. By-products include solids which can be used for animal bedding or as a nutrient-rich soil amendment. Wisconsin has 21 anaerobic digesters operating or in development on farms.

**Pyrolysis** decomposes organic materials at high temperatures in an oxygen-free environment. This technology is currently being tested in a demonstration project in Cashton, WI. The pyrolysis process produces bio-oil, char and syngas. The syngas can help provide the heat needed for pyrolysis. Value added markets for the bio-oil and char need development, but each can be further processed or burned as fuel. The char also has potential value as a nutrient rich soil additive.

**Combustion** is an old manure management technology that is getting a new look, often involving productive uses of the char. While eliminating the potential to develop further uses of the by-products, combustion greatly reduces the manure mass and simplifies disposal. This technology currently is in use on one farm and under development on two other Wisconsin dairy farms.



Courtesy: Energy Center of Wisconsin

### BIOREFINING OF TRADITIONAL CROPS

Wisconsin is rapidly developing ethanol production utilizing corn. An estimated 160 million gallons will be produced in 2006 using nearly 20 percent of Wisconsin's corn crop. Biodiesel production from soybeans is a more recent development and is currently being pursued aggressively in Wisconsin and the region.



Photo by Warren Gretz  
Courtesy DOE/NREL

Biobased industry development will complement, and in many ways, be modeled after the significant progress made in Wisconsin with life science biotechnology. There is a great body of common knowledge and skills that can and should be transferred.

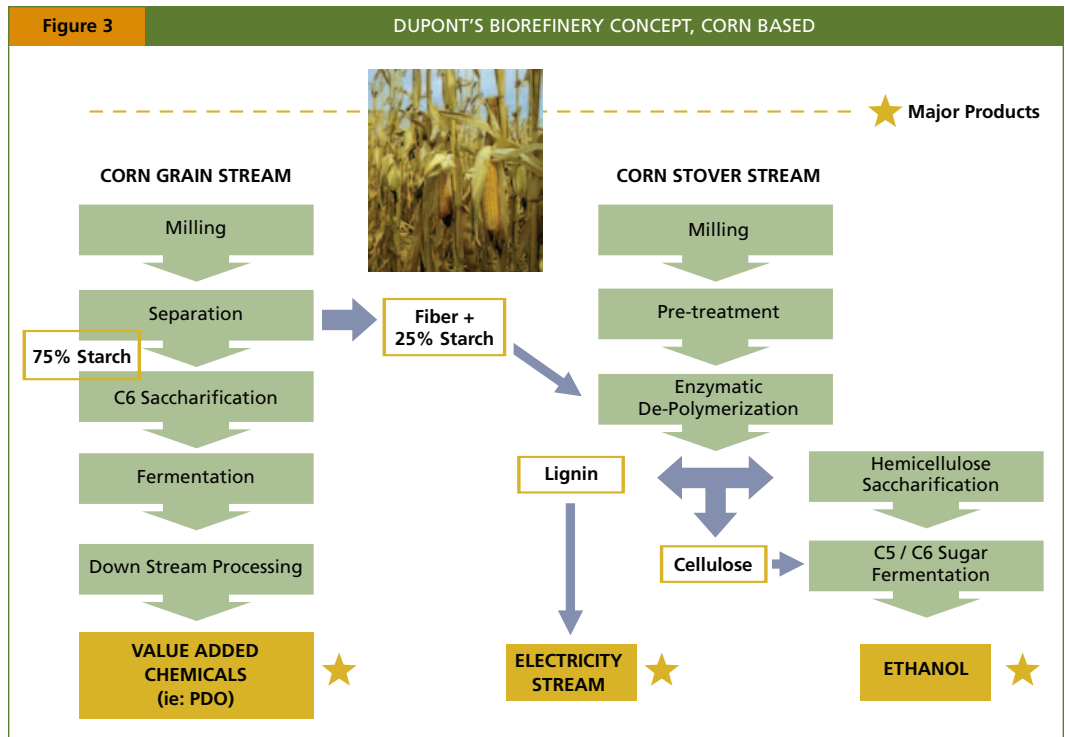
(right) DuPont has already developed new business based on this biorefinery concept.

Source: informa economics



Photo by Warren Gretz  
Courtesy DOE/NREL

The primary bioindustry opportunity for crop and wood residue lies in the development and commercialization of cellulosic ethanol production.



Ethanol is generally produced by fermentation of corn sugars, while biodiesel is the result of a transesterification process. As discussed below, corn and soybeans each offer vast potential as chemical feedstocks.

#### CROP AND FOREST RESIDUES

Crop residues, such as corn stover, straw and soybean stubble, serve a valuable purpose in soil nutrient retention, carbon recycling and as erosion preventing ground cover. It also offers a low-cost feed for animal grazing. Forest residues, likewise, offer nutrient benefits in the forest. Given these traditional uses, markets for additional uses have not developed. Still, experts think that, using no-till cultivation, as much as 60% of the corn stover could be harvested for other higher value uses. Because no-till agriculture is more energy efficient and soil conserving, these additional uses could help encourage the adoption of no-till practices. Improved harvesting processes and producer education are needed to develop markets.

The primary bioindustry opportunity for crop and wood residue lies in the development and commercialization of cellulosic ethanol production. A great deal of research is being directed to that end. Neither the nation nor the state can meet its goals for the production and use of ethanol by relying solely on corn. These goals depend on the commercialization of cellulosic ethanol technology. One estimate is that the current corn cellulose in kernels and stover could account for over 350 million gallons of ethanol, over twice today's production rate.<sup>7</sup> In addition to the processing technology, cellulosic ethanol will require significant changes in farming practices, requiring further research and education efforts. Wood residues potentially could be captured without fundamentally changing forest management practices, though the value of those residues for habitat and nutrient recycling needs to be taken into account.

Beyond use as an ethanol feedstock, low value crop residues hold a longer term prospect of

<sup>7</sup> Energy Center of Wisconsin, Biobased Industry in Wisconsin: Technical Report, Dec, 2005.

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becoming a feedstock for chemical production, an even higher value use. If successful, crop residue could go from a low value waste product to a highly valuable chemical feedstock.

Another, lesser known, use of crop residues, particularly straw and corn stover, is for fiber composite manufacturing. These composites could replace some plastics or fiberglass in a wide range of uses but most likely in auto and machinery body parts. There are numerous challenges to overcome to gain market acceptance and significant research and development is needed.

### THE BIOREFINING OF FOREST AND PAPER PRODUCTS

Wisconsin's forest products industry is a leading provider of high wage jobs, with over 93,000 total jobs and wages in excess of \$3.5 billion. Wisconsin has been the leading paper producer in the U.S. for more than 50 years but it now faces significant competitive threats. The shorter growing cycle for tropical hardwood, coupled with lower operating costs, creates a significant cost advantage for developing countries in warmer climates. Domestically, Wisconsin mills face a technological challenge. Led by the American Forest and Paper Association through its Agenda 2020 process, paper mills, in cooperation with federal and state governments, are exploring significant new technologies and approaches intended to create the integrated forest biorefinery. If it is to maintain its market leadership in the paper industry, Wisconsin must deploy state-of-the-art technology and develop its own integrated forest biorefinery.

The Integrated Forest Biorefinery involves four key technologies, each of which can be implemented separately.

**Value Prior to Pulping (VPP)** In the paper making process, wood chips enter the pulping process where the cellulose, which is used for actual paper production, is separated from the hemicellulose and lignin. These are ultimately

burned for heat and to recover pulping chemicals. The VPP process would extract a portion of the hemicellulose and acetic acid from the chips before they enter the pulping process. The acetic acid can be processed for sale and the hemicellulose can be fermented into ethanol or other higher value products.

The opportunities study calculated that eight mills in Wisconsin could make use of this technology to produce 40 million gallons of ethanol and 12 million gallons of acetic acid annually. As with other ethanol producers, the product stream could be converted to other higher value uses as they develop and become commercially feasible. The VPP process softens the wood chips so that as they continue through the pulping process approximately 30% less energy is required to completely pulp them. Further research is being conducted to determine the impact of the VPP process on the ultimate fiber quantity and quality.

**Black Liquor Gasification (BLG)** After the pulping process, mills today send the chemical-laden liquid, known as black liquor, to a boiler where it is burned to recover the expensive chemicals for reuse and to provide heat for electric generation and/or process steam. The BLG process would recover more energy and produce a syngas fuel that could be used to replace natural gas used in the paper mill. It could also be used to fuel a combustion turbine to produce both heat and power for the plant. A rough estimate indicates that a large Wisconsin paper mill could produce 500,000 MWh of electricity annually, enough to power 59,000 homes and perhaps make the mill a producer of electricity for the grid rather than one of its largest users.

In addition to internal uses, the syngas produced in the BLG process could be used in a Fisher-Tropsch process to produce diesel fuel or gasoline substitutes. In the long term, because syngas is hydrogen rich, it could be used to produce hydrogen for fuel cells. However, these more advanced uses of the syngas are largely experimental at this point.



Photo by Warren Gretz  
Courtesy DOE/NREL

Wisconsin's forest products industry is a leading provider of high wage jobs, with over 93,000 total jobs and wages in excess of \$3.5 billion.



Photo by Bob Allan  
Courtesy DOE/NREL

The first step is to create awareness of the opportunities to form biorefining partnerships.

**Biomass Gasification** In addition to the recovery boiler, many mills have solid fuel boilers that burn waste wood and coal. Once a BLG system is in place, it is easy to replace those boilers with biomass gasifiers that produce additional syngas to supplement the stream from the BLG process. Such a gasifier could also be capable of gasifying materials from outside the paper mill. This would create the opportunity to integrate agricultural and forest residues, other waste streams, and even dedicated energy crops into a larger bioenergy production process.

**Wastewater Digestion** Many mills have their own wastewater treatment facility to handle the large volumes of wastewater generated in the papermaking process. This wastewater can be sent to an anaerobic digester and converted to a usable fuel for heat or electricity. The Energy Center of Wisconsin estimates that, as a group, the 20 largest mills in Wisconsin could produce 167,000 MWh of power annually from wastewater digestion.

Two of the above technologies, VPP and BLG, are rather complex installations that are probably applicable to only about 8–10 mills in Wisconsin. However, biomass gasification and wastewater digestion are feasible alternatives at nearly every mill.

The common theme of each of the elements of the integrated forest biorefinery is to develop and use innovative technology to reduce costs and develop additional value added product streams. An aggressive commitment to develop an integrated forest biorefinery in Wisconsin is critical if our paper industry is to remain globally competitive and provide a significant source of locally produced bioenergy. Wisconsin cannot afford to neglect this opportunity.

#### **BIOREFINING OF ORGANIC WASTE STREAMS OF WISCONSIN INDUSTRY**

These waste streams, while plentiful, are too diverse to make a single approach feasible. Organic wastes are generated at 75 fruit and

vegetable processing operations, 284 licensed meat processing facilities, 350 licensed dairy plants, 80 breweries, and 100 municipal wastewater treatment plants. Many have in common a chemical or biological contaminant that confounds the treatment process. Few are large enough to justify their own treatment facility. In almost all cases, the feedstock is treated as a disposal problem to be reduced if not eliminated.

The first step is to create awareness of the opportunities to form biorefining partnerships. Connecting municipal wastes and waste technologies such as anaerobic digesters with nearby industrial users to displace electric or natural gas purchases is an untapped opportunity. Once formed the composition of the joint waste stream may direct the selection of processing technology and the potential bioproducts that will enhance the competitiveness of industry and reduce community waste costs.

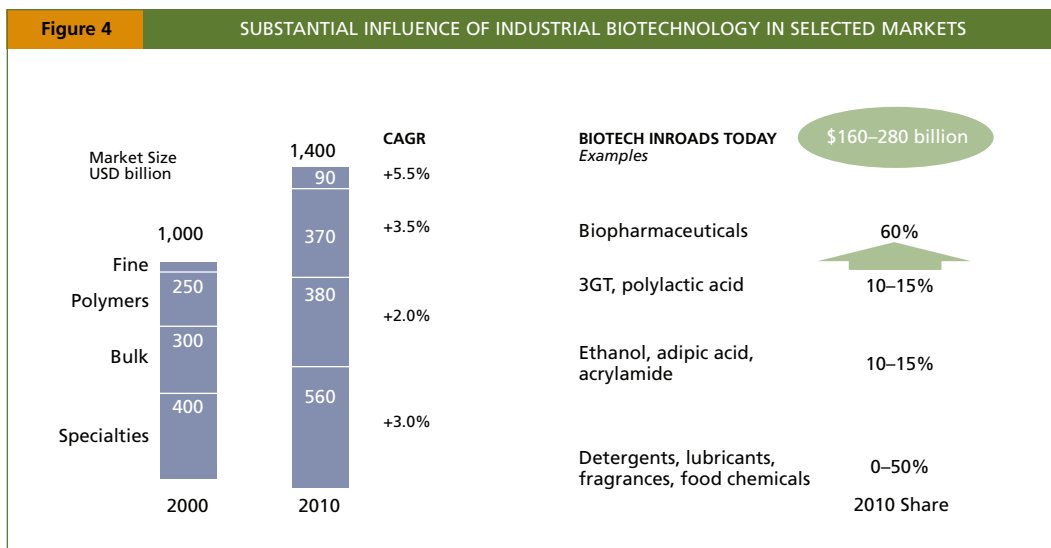
#### **BIOREFINING OF NEW AND DEDICATED CROPS**

New and dedicated crops designed for specific and unique applications in the bioeconomy should be explored. While opportunities are plentiful in concept, the ability to produce bioproducts in a manner that meets performance and cost specifications requires significant development attention. Biobased chemicals, especially specialty and fine chemicals hold the most near term commercial promise. Major chemical companies such as DuPont, Dow and Eastman are quickly advancing in biochemical production. Biochemical production holds promise because of the potential for significantly reduced steps and thus costs in their production plus performance and environmental advantages.

Replacement of imported petrochemicals by domestic biomass could have a huge economic impact on the state's economy. "McKinsey & Co. has estimated that by 2010, some 20% of the \$1.5 trillion global chemical market could be impacted by biobased technologies. That is a new \$300 billion bioeconomy market."<sup>8</sup>

8 Specialty Chemicals, Vol. 23: 6, 2003, page 34.





(left) The chemical industry is expected to grow and the impact of biobased innovations will grow even more rapidly.

Source: McKinsey and Company, 2003

Biochemicals offer a future in which clothing, upholstery fabric, packaging for food and virtually an infinite variety of additional products are produced using corn or syngas as the base feedstock. Most of these potential developments will displace imported petrochemicals with biochemicals. Many experts believe that any product that can be made from a petrochemical can be made with a biochemical.

While the future seems wide open for biobased chemicals, the likely early commercial products will be organic acids, such as acetic acid, lactic acid and its derivatives, and biosolvents and solvent blends. For example, polylactic acid (PLA) is the base for a brand of material that already is being used to package fresh fruit and produce and will ultimately have many other uses.

A second promising area is polyols. In this field, DuPont is capping years of research with the introduction of a biobased version of 1,3 propanediol—a polymer for use in fibers and fabrics. Sorbitol and glycerin are additional biochemicals with near term promise.

The key to developing these and other biochemicals will be to utilize the transportation, handling, manufacturing and marketing infra-

structure established with dry mill ethanol plants. Commercial production of ethanol and biodiesel provides a larger volume base upon which more sophisticated, but smaller volume chemical production can be added.

#### INVESTING IN RESEARCH AND DEVELOPMENT

To achieve a healthy and growing bioeconomy in Wisconsin, further applied and developmental research is critical. Wisconsin has excellent research and development capacity: the University of Wisconsin System and other universities; private companies already participating in the bioeconomy; and two major USDA research laboratories. Finding innovative ways to transfer the technologies resulting from this research will be necessary to translate developments into successful commercial ventures.

The University of Wisconsin–Madison has been ranked in the top five research universities in the U.S. in terms of research expenditures and impact on published research, in areas such as biotechnology and microbiology, as well as many other fields of science relevant to the biobased industry. It houses the University of Wisconsin Biotechnology Center, one of the leading centers for genomic research in the world, and will soon be completing hundreds of millions of dollars worth of major building



Photo by Bob Allan  
Courtesy DOE/NREL

Biochemicals offer a future in which clothing, upholstery fabric, packaging for food and virtually an infinite variety of additional products are produced using corn or syngas as the base feedstock.

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projects relevant to biobased science, such as the new Bacteriology/Microbiology/Food Science Center and the Wisconsin Institute for Discovery. The Wisconsin Alumni Research Foundation (WARF) handles patenting and licensing of University inventions and uses revenue to fund early stage research. It is recognized as one of the oldest and best such organizations in the world. In 2004, WARF provided \$55.5 million for 1,400 research projects. Each of these University units can play a significant role in the development of Wisconsin's emerging leadership in the bioeconomy.



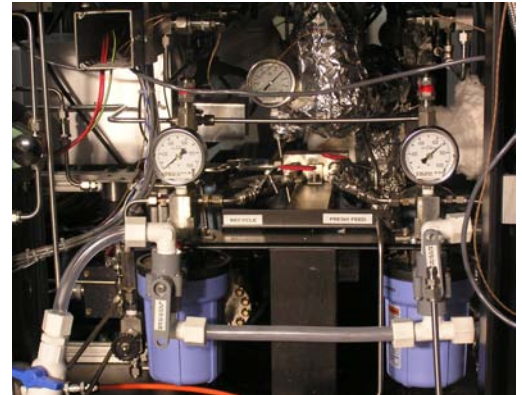
Photo by Warren Gretz  
Courtesy DOE/NREL

Wisconsin has strong capacity and capability to conduct and commercialize bioeconomy research and development.

Additional research capacity for specific industries are: the UW–Green Bay which hosts the Paper Technology Transfer Center; the UW–Milwaukee College of Engineering and Applied Science which hosts the Center for By-Products Utilization and the Alternative Fuels Center; the UW–Stevens Point College of Natural Resources which boasts leading programs in forestry and paper science and enjoys a long history of training pulp and paper industry leaders.

Several small high-tech companies conduct bioeconomy related research in Wisconsin.

- Forage Genetics International is Monsanto's partner in alfalfa centered biotechnology.
- Lucigen has focused on developing enzymes to improve ethanol production and has the additional capability to support any company pursuing bioprocessing.
- Agricetus, which has recently been acquired by Monsanto, focuses on soybeans, cotton, rice and the nutritional content of plants.
- Promega provides specialized tools and equipment to biotech researchers.



(above) Aqueous Phase Reforming (APR).

Courtesy: Virent Energy Systems, Inc.

- Virent Energy Systems uses aqueous phase reforming technology to produce hydrogen, and other products from carbon rich feedstocks. This technology has the potential to connect Wisconsin's developing bioeconomy with the long-term hydrogen economy.

Another component of Wisconsin's research capability is the USDA Forest Products Laboratory. This lab is the nation's leading forest products research facility. The USDA Dairy Forage Research Center, which focuses on plant development and use, is another potential resource.

Wisconsin has strong capacity and capability to conduct and commercialize bioeconomy research and development. A focus on industrial bioeconomy development as a complement to life science biotechnology is mutually reinforcing.





## STRATEGIC FRAMEWORK FOR MOVING FORWARD

**W**isconsin needs to distinguish its investments in biobased technologies and opportunities based on developmental stage and risk. Concentrating solely on well established, low risk technologies is unlikely to move the state into a leadership position. Concentrating on unproven, high risk technologies would be costly, risky and unlikely to provide predictable benefits. The Consortium identified three critical overriding strategies for Wisconsin to realize the potential of the emerging bioeconomy without undue risks and with good prospects for rewards.

### Strengthen Wisconsin's Core Industries

Retaining, strengthening and growing existing core industries through bioindustry technology adoption should be a priority strategy. Wisconsin's historically high value adding agriculture, food, wood and paper industries, now threatened with competitive challenges, can reduce costs and strengthen competitiveness through integration of biorefining technologies. The use of forest biorefining technologies in paper making is a prime example. We should employ strategies that ensure promising technology adoption occurs in these industries. We need to work strategically with other core industries such as printing, plastics and electronic componentry to pull biobased products and technologies into their processes and products to create competitive advantages. Adopting bioindustry technologies will add to

the ongoing economic development efforts to strengthen Wisconsin's agriculture, forest products and core manufacturing sectors.

### Enhance Emerging Biobased Industries

Wisconsin's biobased businesses and emerging industries that carry maturing biobased technologies need continuing support to expand their markets and move the state into a leadership position. Wisconsin's rapidly growing ethanol industry and the market for anaerobic digesters are two such examples. These emerging industries and technologies need a supportive climate of economic development programs, efficient and effective regulatory oversight, and market friendly programs that encourage market building through a variety of mechanisms.



Photo by Warren Gretz  
Courtesy DOE/NREL

Additional priorities should be assisting Wisconsin's ethanol industry to advance to high value biochemical products and helping make anaerobic digesters more cost effective and more scaleable for more Wisconsin farms.

For example, an auto manufacturer has introduced a flex-fuel vehicle that delivers greater horsepower than its gasoline equivalent and also shows a 15% fuel economy improvement at cruising speeds. Other technologies include 100% ethanol (E100) vehicles that deliver better performance than equivalent gasoline fueled vehicles and produce zero fossil fuel emissions. These performance improvements could dramatically change the image and marketplace acceptance of ethanol. The ethanol industry in Wisconsin and in the Midwest would benefit greatly from efforts to accelerate the commercial introduction of these new automotive technologies.

Additional priorities should be assisting Wisconsin's ethanol industry to advance to high value biochemical products and helping make anaerobic digesters more cost effective and more scaleable for more Wisconsin farms.

### Establish Leadership in "Leapfrog" Technologies

Discoveries that leapfrog intermediate processes or existing infrastructure offer the opportunity to develop and commercialize significant new technologies. Developing these technologies is the third component of the Consortium's strategic framework to help Wisconsin distinguish itself as a leader in the bioeconomy. Here the University of Wisconsin's capabilities in plant genomics and plant biochemistry are critical to Wisconsin's bioindustry progress and continued investments to strengthen that capacity should be a priority.

Following this strategic framework, the Consortium believes that Wisconsin can lead development of the bioeconomy by:

- Integrating biorefining technologies into existing manufacturing industries especially clusters like food and paper, environmental wastes, and new revenue streams from co-products. Printing, plastics and the auto industry are additional sectors that can benefit from this effort.
- Developing stair stepping technologies to increase efficiencies of emerging biofuel and bioenergy companies and to transition to the production of cellulosic ethanol, value added chemicals and products.
- Developing novel enzymes, proteins, biocatalysts and bacteria to support process innovation and product development, including cellulosic ethanol and value added chemicals and biopharmaceuticals and nutraceuticals.
- Becoming a major exporter of biobased technologies in the form of enzymes, biocatalysts, equipment and devices and services.
- Reducing its reliance on imported energy.
- Protecting the environment through bio-product manufacturing and consumer use.

## CONSORTIUM RECOMMENDATIONS



# The Consortium

reports these recommendations in four broad categories.

### **Organizing a Sustained and Integrated Effort**—

Create a dedicated organization that brings together university, private and government sectors to coordinate efforts, identify potential multi-disciplinary opportunities for cooperation, and provide needed services to bioindustry stakeholders.

**Building Research, Education, Training and Outreach Capacity**—Develop the intellectual resources critical to success in the bioeconomy.

**Seizing Business Opportunities**—Develop policies and programs, including financial support, that help existing businesses take advantage of biobased industry opportunities and that help entrepreneurs create biobased businesses.

**Developing Markets**—Work cooperatively with bioindustry producers to develop markets for their products and improve market acceptance of new bioindustry technologies and products.

Additionally, regional cooperation and a national presence will be highly beneficial to

Wisconsin's bioindustry. Governor Doyle has stated that we are competing with the Middle East, not the Midwest. Many of the resources and drivers that make the bioindustry so attractive to Wisconsin are also applicable to neighboring states. The Midwestern states have more to gain by collaborating to develop markets and accelerate technology adoption than they do by acting independently.

### **Organizing a Sustained and Integrated Effort**

The Consortium recommends creating the Wisconsin BioIndustry Partnership (WBIP) to guide the implementation of the Consortium's recommendations.

One of the Consortium's key findings is that there is no existing mechanism to bring business leaders together to learn about opportunities for development, build collaboration and induce public sector action. Yet, success in the bioindustry demands strong commitment and consistent follow through from the busi-



Photo by Warren Gretz  
Courtesy DOE/NREL

Success in biobased development requires a workforce development focus.

ness community, state government and the university research community acting together. As a foundation for this effort, the Consortium sees the need for a dedicated organization to integrate and coordinate these efforts.

A dedicated organization will serve as a single point of contact in Wisconsin and support the work of entrepreneurs and businesses in the bioeconomy. The members of the WBIP should include leaders from the private, public and university sectors. In addition to developing the implementation plan, the WBIP could be used by the Governor to monitor progress, provide strategic direction, make policy and program recommendations and ensure Wisconsin stays on a fast track to bioindustry development.

The WBIP should develop specific policies, programs and activities that include the following:

**Grant Access.** Help firms and researchers access state, federal and private grants and provide money to assist them in effective grant writing.

**Technical Assistance to Business.** Ensure that entrepreneurs have access to expertise in bioindustry development as well as to the start up and ongoing technical assistance that is needed by all businesses.

**Regulatory Facilitation.** Develop a framework that enhances the ability of regulators to understand bioindustry technology development and allows them to act in a timely manner on permitting issues. This framework should also help bioindustry firms to take advantage of Green Tier, reduce regulatory business risks, allow WBIP to participate in regulatory policy development, protect the environment and provide a neutral forum to resolve science issues surrounding biobased industry developments. Building structural ties to the Wisconsin Distributed Resource Council on renewable energy distribution issues and to DNR's Innovation Stakeholder Group are key to developing innovative ways to support biobased industry development.

**Data Tracking.** Identify data, including geographic information, to be tracked to monitor progress and to support decision making for biobased business development.

**Regional and National Collaboration.** Identify the most critical public and private institutions with whom to collaborate on bioindustry development so as to avoid costly duplication and enhance Wisconsin and regional emergence in biobelt bioindustry development.

**Documentation and Capture of Environmental Benefits.** Assist in the documentation of environmental impacts and benefits of bioindustry technology adoptions. This documentation is necessary both for public awareness and for land owners and businesses to take advantage of the growing and emerging markets for green credits and carbon credits for which biobased industry development will qualify.

WBIP will need specific authorities and staffing to do this job and to accomplish the goals set forth by the Consortium. It also can maximize coordination and linkages with existing organizations in order to minimize redundancies.

## Building Research, Education, Training and Outreach Capacity

The Consortium recommends enhancing biobased research and outreach capacity funding. Further, education and training efforts at all levels should be strengthened. Biobased industry development (e.g. industrial biotechnology) dovetails readily with life science and biomedical biotechnology capabilities. Thus, building new capacity will be more incremental than starting from scratch.

Success in biobased development requires a workforce development focus. A new industrial biotechnology focus at the University of Wisconsin would increase access to federal research funding and improve ties among Wisconsin and other regional industries and research organizations already heavily invest-

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ed in industrial biotechnology research. The WBIP should create detailed plans to:

- Develop research priorities and guiding mechanism to help tie research to the needs of the bioindustry.
- Maintain, and even extend, the world class status of University research by working to provide adequate funding for basic research in the plant and biosciences fields. This research is the most likely source of the breakthrough discoveries that will become the “leapfrog” technologies that Wisconsin businesses will need to establish market leadership in the bioindustry.
- Fund applied research projects, in addition to basic research, within the University system. Funding programs should include accountability and governance provisions designed to ensure that Wisconsin business have the opportunity to benefit from the research.
- Identify and work with private organizations such as the Wisconsin Technology Council, the Wisconsin Entrepreneur’s Network, large investment funds, private angel investor networks, and environmental organizations to broaden the outreach to industry and residents about the impacts and benefits of bioindustry.

## Seizing Business Opportunities

Businesses and entrepreneurs need a broad range of support when embarking on new ventures or embracing new technologies. This support can be financial, infrastructure enhancements or improvements and market development and commercialization.

### FINANCIAL AND INFRASTRUCTURE SUPPORT

The Consortium recommends creating a broad-based program of support for biobased enterprises. The support program should help improve access to technical and financial assistance and develop needed infrastructure for the bioindustry. The WBIP should develop implementation plans to:

- Continue and expand funding for existing bioindustry grant programs operated by the Department of Agriculture, Trade and Consumer Protection and the Department of Natural Resources.
- Develop incentives for municipalities to invest in municipal waste systems that use solid and liquid waste as an energy source.
- Analyze and design a comprehensive series of innovative financing tools and incentives for firms in the bioindustry, including tax, equity capital, and lending instruments. These financing tools should help reduce risks and increase access to capital for new and expanding bioindustry firms. They should also address all stages of the commercialization process from technology adoption through early stage production incentives to market support functions.
- Determine whether there is a market need for a bioindustry incubator to provide space for high value bioindustry development firms and fill the gap between resources and space at the University of Wisconsin–Madison and facilities at the University Research Park.

### TECHNOLOGY TRANSFER

The Consortium recommends a sustained focus on the commercialization of bioindustry technologies. Research and training investments result in high economic paybacks. The Consortium has found that the risks of adopting new and often costly technology advancements are too high for many firms to handle on their own. In addition to financial support, they will often benefit by access to the knowledge base of specialists in the new technologies. This technology transfer function requires a wide range of dedicated expertise to facilitate and lead projects designed to integrate new technology into business operations. The WBIP should develop implementation plan to:

- Identify private technology experts and facilitate their partnerships with Wisconsin bioindustry firms.



Photo by Warren Gretz  
Courtesy DOE/NREL

Businesses and entrepreneurs need a broad range of support when embarking on new ventures or embracing new technologies. This support can be financial, infrastructure enhancements or improvements and market development and commercialization.

- Develop partnership programs with existing organizations that offer technology transfer and other services that are applicable to the bioindustry.
- Create business models in the agriculture sector that support local ownership including farmers, farmer participation in value chains, and community participation.

## Developing Markets for Biobased Industries

The Consortium recommends that the WBIP work with bioindustry stakeholders to develop specific actions to develop markets for new or improved biobased products. Creating demand for new products must overcome consumers' lack of information and perception of higher risk. Bioindustry firms will need more than a strong advertising campaign to accomplish this.

The Consortium supports a requirement that all gasoline sold in Wisconsin contain at least 10% ethanol. Such a requirement would not only increase the market for ethanol, it would send a strong signal about the stability of the Wisconsin ethanol market. Investors would be able to justify long-term capacity additions based on a more secure market size analysis. Another valuable means of expanding demand for ethanol in Wisconsin will be a strengthened E-85 voluntary purchase program.

Further, the Consortium strongly believes that Wisconsin would benefit from the development of a cellulosic ethanol production capability. In addition to capacity building efforts, cellulosic ethanol should be granted extra credit, in a manner similar to that incorporated in the federal Energy Security Act of 2005. This federal legislation requires the use of 7.5 billion gallons of ethanol by 2012 and counts cellulosic ethanol as equal to 2.5 times the volume of corn-based ethanol in meeting the requirement.

Wisconsin currently has a small but growing biodiesel production capability. Immediate efforts should focus on encouraging production capacity. Only as the capacity starts to come on line should market development efforts be undertaken. At that time many of the same programs used in building the ethanol market can be redirected to biodiesel market development.

The Consortium also supports the development of a State Biobased Product Procurement Program modeled on the Federal Biobased Products Preferred Procurement Program (FB4P). Congress mandated this program in the Farm Security and Rural Investment Act of 2002. It is managed by the U.S. Department of Agriculture which provides information to federal agencies to help them comply with the regulations. They are creating an official "U.S.D.A. Certified Biobased Product" label that manufacturers can use to identify their qualifying biobased products.

## Results Focus

Finally, the Consortium recommends that the entire Wisconsin bioindustry program be subject to regular program evaluations. Evaluations will ensure a focus on results and lead to continued improvement in programs offered and policies adopted. The WBIP may choose to have individual program elements evaluated at times it considers most appropriate. However, the entire range of programs and policies should be subject to a biennial comprehensive evaluation.

Ultimate accountability for Wisconsin's efforts to support a bioindustry sector lies with a strong public private partnership. The WBIP should prepare an annual report to the Governor and Legislature. The report should describe WBIP activities and focus on the results of those activities.



Photo by Art Wiseloge  
Courtesy DOE/NREL

Ultimate accountability for Wisconsin's efforts to support a bioindustry sector lies with a strong public private partnership.





## CONCLUSIONS

**G**overnor Doyle asked the Consortium to validate whether the bioeconomy offers major economic advantages for the State of Wisconsin. The answer is a strong and unequivocal yes; the bioeconomy offers the most significant economic opportunity for Wisconsin in our generation.

Anticipating this answer, the Governor asked, "What does the State of Wisconsin need to do in order to make sure that Wisconsin businesses and residents realize the benefits of that opportunity?"

The Consortium believes that the basic strategy recommendations it has set forth provide the direction Wisconsin needs to move aggressively and rapidly forward in the bioeconomy. It has presented a comprehensive set of measures designed to meet the important needs of the bioeconomy. Government actions are needed in order to succeed, along with public/private partnership to guide and implement the strategies.

Wisconsin must make significant investments in organization, research and development, commercialization and technology transfer, business incentives and financing, market development and communications and outreach. Over time these investments will give Wisconsin a leadership role in the bioeconomy and the sustained effort will prove to be highly rewarding for the state.

Each year the United States imports 3.6 billion barrels of oil. In May of 2006, that oil sells for over \$70 a barrel. That means we spend over one-quarter trillion dollars annually to import

oil. If we meet the federal goal of replacing 30% of our petroleum with biofuels, biopower and bioproducts, we will have moved a \$77 billion per year market from overseas into the United States.

If Wisconsin can move to claim a significant share of that market, we will have created billions of dollars worth of new business in our state. That translates to more and better jobs, as well as more and better investment opportunities. Much of that new investment will be in the agriculture and forest products industries that have sustained Wisconsin throughout the years. Even more of that investment will be in the manufacturing industry that constructs and equips the new plants of the bioeconomy, not only in Wisconsin, but throughout the world.

If we can supply a large portion of this new demand with the biomass resources from the farms and forests of Wisconsin, we will have made a major contribution to reducing greenhouse gases and other air and water pollutants in Wisconsin and around the world.

The Consortium strongly urges the Governor to accept these recommendations and commit the State of Wisconsin to success in the bioeconomy.



**RELATING TO THE DEVELOPMENT AND PROMOTION OF BIOBASED INDUSTRY**

**WHEREAS**, current biobased product and bioenergy technology has the potential to make renewable farm and forest resources major sources of affordable electricity, fuel, chemicals, pharmaceuticals and other materials; and

**WHEREAS**, technical advances in these areas can create an expanding array of new businesses and employment opportunities for farmers, forest products companies and other businesses in Wisconsin, and

**WHEREAS**, these technologies can create new markets for farm and forest bi-products and residuals, new economic opportunities for underused land and new value-added business opportunities; and

**WHEREAS**, they also have the potential to reduce Wisconsin's dependence on foreign oil, improve air quality, water quality and flood control, decrease erosion and help minimize net production of greenhouse gases; and

**WHEREAS**, it is the policy of this Administration, to develop a comprehensive state strategy, including research, development and private sector incentives, to stimulate the creation and early adoption of technologies needed to make biobased products and bioenergy cost-competitive in large national and international markets;

**NOW, THEREFORE, I, JIM DOYLE**, Governor of the State of Wisconsin by the authority vested in me by the Constitution and the Laws of this State, and specifically by Wis. Stat. §14.019, do hereby:

1. Establish the Consortium on Biobased Industry (the "Consortium"); and
2. Direct the Secretaries of Agriculture, Trade and Consumer Protection, Natural Resources and the Administrator of the Department of Administration Division of Energy to consult with the Governor regarding potential members of the Consortium; and
3. Provide that the Consortium will include up to 20 members of stakeholders including representatives from the farm, forestry, chemical manufacturing and other businesses, energy companies, electric utilities, environmental organizations, the university research community and other critical sectors; and
4. Provide that members of the Consortium may serve on the Consortium through designees; and
5. Provide that the Consortium shall have the following mission:
  - a. Recommend short-term and long-term policy and commercialization strategies for the Governor outlining overall state goals and actions that promote the development and use of biobased products and bioenergy in an environmentally sound manner; and
  - b. Propose how these goals can best be achieved through federal and state programs, integrated planning and regional cooperation; and

- c. Identify mechanisms that would encourage and support private sector initiatives in biobased product development; and
  - d. Advise on policies at the state and federal level that would support development of biobased products and energy and new and expanding markets to support them; and
6. Provide that these recommendations shall:
- a. Cover biobased products, including commercial and industrial chemicals, pharmaceuticals, products with large carbon sequestering capacity and other materials; and
  - b. Cover biomass used in the production of energy (electricity, liquid, solid and gaseous fuels and heat); and
  - c. Include a description of priorities for research, development, demonstration and other investments in biobased products and bioenergy; and
  - d. Include a list of current federal research programs and funding to target; and
  - e. Include proposals for using existing agency authorities to encourage the adoption and use of biobased products and bioenergy and recommended legislation for modifying these authorities or creating new authorities if needed; and
7. Require the Consortium to submit a final report on its findings and recommendations to the Governor and that the Consortium shall dissolve when its final report is accepted by the Governor.

**IN TESTIMONY WHEREOF,** I have Hereunto set my hand and caused the Great Seal of the State of Wisconsin to be affixed. Done at the Capitol in the City of Madison this twenty-seventh day of May in the year two thousand five.

/s/ Jim Doyle

By the Governor:

/s/ Douglas La Follette

JIM DOYLE  
Governor

DOUGLAS LA FOLLETTE  
Secretary of State

**JOHN MALCHINE, CO-CHAIR**

CEO & Chairman  
Badger State Ethanol

**THOMAS SCHARFF, CO-CHAIR**

Director of Power & Energy  
StoraEnso NA

**JAN ALF**

Director, Business Development  
Forward Wisconsin

**ERIC APFELBACH**

President & CEO  
Virent Energy Systems

**SUE BEITLICH**

President  
Wisconsin Farmers Union

**BILL BRUINS**

President  
Wisconsin Farm Bureau Federation

**BRUCE BULLAMORE**

Executive Director  
Richland County Development Corp.

**EARL J. GUSTAFSON**

Vice President, Energy, Forestry and  
Human Relations  
Wisconsin Paper Council

**CRAIG HARMES**

Business Development  
Dairyland Power Cooperative

**CHARLES HILL**

Sobota Professor, Chemical Engineering  
UW- Madison

**JOHN IMES**

Executive Director  
Wisconsin Environmental Initiative

**JOHN LAWSON**

Senior Executive Vice President  
Boldt Construction

**SUE LEVAN**

Program Manager  
US Forest Products Lab

**ROBERT SHERMAN**

Environmental Manager  
Kraft Foods

**MICHAEL SUSSMAN**

Director, Biotechnology Center  
University of Wisconsin

**SCOT WALL**

President  
Bank of Cashton

**HOLLY YOUNGBEAR-TIBBETS**

Dean  
Sustainable Development Institute  
College of Menominee Nation

**KIM ZUHLKE**

VP, New Energy Resources  
Alliant Energy